HATCHING IN THREE SPECIES OF NEUROPTERA.*

Roger C. Smith,
Associate Professor of Entomology,
Kansas State Agricultural College, Manhattan, Kansas.

This paper deals with the process of hatching in three species of Neuroptera, viz., *Chauliodes pectinicornis* Linn, *Micromus posticus* Walker, and *Chrysopa oculata* Say. The observations were made with special reference to the egg bursters. This account is therefore a brief description of the appearance of the eggs at hatching, the process of hatching and a description of the special structure enabling the embryo to leave the shell. This structure in the three species mentioned is of the same general type, but there are important differences. The general process of hatching in each case, as well as the appearance of the eggs at hatching, are very similar.

1. **Chauliodes pectinicornis** Linn.

The function of the egg burster in this species was observed in 1912 by H. S. Barber, who did not publish upon the subject. He very kindly sent the writer his sketches and photographs and supplied the fresh material upon which these observations were made. This material consisted of a large number of eggs deposited June 16, 1919, in confinement by a gravid female caught at lights at Plummer's Island, Maryland. When received, June 20th, they showed advanced embryological development and hatched under the writer's observation June 24th.

The eggs all lay on what was the dorsum of the embryo (Fig. 4), the ventral side up, and with the prominent knobbed micropyles all pointing the same direction. When these eggs were ready to hatch, the two black eye spots could be very plainly seen each side the mid-ventral line and near the micropylar region. A little posterior to these were the very prominent bifid amber-colored mandibles. Furthermore, in the mid-ventral line between the eyes and above the mandibles was seen a thin chitinous carina resembling a small knife blade. This

* Contribution No. 78 from the Entomological Laboratory, Kansas State Agricultural College.

was found to be the egg burster. It could be seen that it was bilobed, but the upper lobe showed the more distinctly. In this case the eggs hatched when these characters showed most plainly. The warmth of an electric light bulb after a cool night started the whole mass hatching.

The first evidence of the beginning of hatching observed with a binocular was a very slight raising and lowering of the mandibles, effected, it is believed, by the embryo working itself upward then receding slightly. The upward movement was somewhat quicker than the downward one. The head was gradually advanced, thereby bringing the burster next to the chorion. This movement continued from one to four minutes

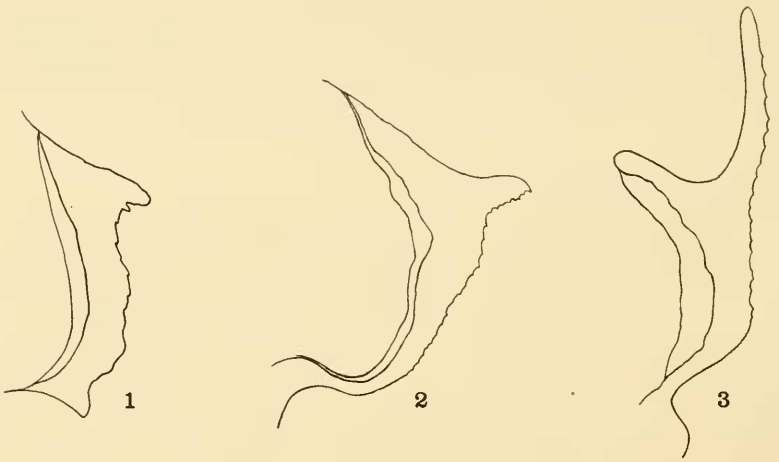

Fig. 1. The egg burster of *Chauliodes pectinicornis* Linn. × 215.
Fig. 2. The egg burster of *Chrysopa oculata* Say. × 300.
Fig. 3. The egg burster of *Micromus posticus* Walker. × 300.

in different eggs observed. Finally the upper lobe punctured the chorion and a slit was cut for the entire length of the burster. The embryo forced the soft clypeal region through the opening, which caused the rent to broaden, then tear, almost entirely at the upper end. The clypeus was translucent to grayish in color, so contrasted sharply with the chorion. The embryo forced its head through the rent, followed by the thorax, but the chief advance was made by the dorsum. When the embryo had emerged to about half its length, it stopped and prepared to cast the embryonic molt.

One could very clearly discern a little stream of silvery bubbles of air entering the pharynx and collecting in the intestine, thereby causing an observable inflation. As a result of this inflation in the thoracic region, together with the shifting forward of the embryo, the thin membrane parted over the prothorax in the mid-dorsal line. This rent rapidly lengthened to the metathorax. The larva then pushed its thorax through the rent, bending its head ventrad. The thin membrane slipped off the mouthparts very slowly. In a minute or so the head was pulled free and the larva rested supported by the end of the abdomen until the chitin hardened. After about thirty minutes the larva pulled its abdomen from the molt and walked away. This molt lay in a crumpled heap in the lower end of the rent. The entire process of hatching from the first visible movements to walking away required about forty-five minutes.

The egg burster (Fig. 1) is a thickening and specialization of the embryonic cuticula* over the anterior part of the head in the median line. The burster proper is an inverted V-shaped ridge, with upper and lower lobes between which the carina bends outward and is beset with about ten minute teeth or irregularities. At the sides, the heavy chitinized parts are continuous with the molt, but the line of demarcation can generally be distinguished.

2. **Micromus posticus** Walker.

Hatching in the Hemerobiidæ has been observed by the writer in four species, viz., *Hemerobius humuli*, *H. stigmaterus*, *Sympherobius amiculus* and *Micromus posticus*. It occurred in the same way in all these species, the few differences recorded are probably individual. As a type for the family, hatching in *Micromus posticus* will be described. This species is one of the most abundant in the eastern part of the United States, and one of the larger ones in size.

The chorion was observed to be entirely smooth, unsculptured, shining and irridescent. As embryological development proceeded, the outlines of the embryo could be readily seen, since the chorion was very transparent. When the eggs were ready to hatch, the three pairs of thoracic gray color patches

* Smith, Roger C. The Process of Hatching in Corydalis cornuta Linn. Annals Ent. Soc. Amer., Vol. XIII, pp. 70-74, 1920.

could be distinctly seen. The posterior three-fourths of the egg was pinkish, even reddish. In the mid-ventral line, just below a line connecting the eyes, could be seen the egg burster. The eggs lie on the dorsum with the venter uppermost. Just before hatching the egg burster and the general coloration of the embryo appeared quite distinct.

The first visible evidence of the beginning of hatching was certain peristaltic movements of the abdomen. The embryo appeared to push itself upward by means of the abdomen. The end of the abdomen was first pulled by these so-called peristaltic movements towards the posterior pole of the egg and as a result of crowding there, pressure was exerted at the anterior pole. This upward pushing, it has been observed, may continue at intervals for ten to thirty minutes. As a result of this pushing, the egg burster was closely applied to the chorion. As the pressure continued, the upper end of the toothed burster was pushed through the chorion. It is difficult to ascertain sometimes the exact time the burster pierces the chorion, for, under pressure the burster often appears through when it is not yet through, due to the transparency of the chorion. After the upper end of the burster was through the chorion, the upward and outward thrusts of the embryo became more pronounced. At each upward thrust, more of the chorion was cut, the cutting proceeding away from the micropyle. By this time the clypeal region of the head of the embryo could be seen in the rent. It was dull and whitish in contrast to the shining glassy chorion. The burster cut to its full length, and in the meanwhile the embryo pushed its head through the upper part of the rent. This is followed by the thorax and a part of the abdomen. At the time that the thorax was well out, the thin embryonic cuticula split over the prothorax, due in part to its being attached to the chorion in the mid-ventral line. The exact time could be ascertained by observing the straightening up of the dorsal setæ. The thorax and a part of the abdomen were pushed through the molt, but the mouthparts and head appendages were retarded so the larva formed an inverted U over the egg. The mouthparts were pulled from this thin membranous cuticula slowly and carefully. The molt with the attached egg burster slipped down between the labial palpi and the antennæ. The burster and the thin shrivelled molt

lodged finally in the lower end of the rent of the chorion. The larva rested until its legs would bear its weight, and then pulled its abdomen from the egg shell and molt. The burster, which is a part of the molt, could be seen with the unaided eye. The entire process from the first piercing of the chorion to walking away requires from 15 to 20 minutes.

The egg burster is again a specialization of the embryonic molt, but differing considerably from those of other families seen. It is a toothed keel, but the upper half is free and extends over the clypeal region of the head. There are no prominent lobes, but the apex of the ridge bears from 15 to 20 small saw-like teeth. There is a rather marked diamond-shaped cap which fits over the buccal region. This cap is thought to be the line of demarcation between the heavier and lighter chitinization of the molt. This burster apparently resembles that of Osmylus as figured by Hagen (1852).

3. **Chrysopa oculata** Say.

Hatching in this species, and in all closely related species of Chrysopidæ so far seen, takes place in a manner almost identical with that described for *M. posticus*. The chief accounts seen in literature concerning hatching in this family are the writings of Hagen (1859, 80) in which reference is made to a cephalic saw by means of which the first opening is effected. Hatching has been incorrectly described by several writers as effected by the mandibles of the embryo piercing the chorion, or the upper end of the egg being cut off. The position of the embryo in the egg would render the first explanation, a priori, impossible and in the case of the second there is no cap on the egg to be lifted.

Eggs ready to hatch show rather clearly the outline and parts of the embryo, as the chorion is transparent to a considerable degree. The two very prominent eyes or ocellar fields stand out clearly and can be seen with the unaided eye. On the ventral side in the mid-dorsal line between the eyes can be seen a short, dark line. This line is the cephalic saw of Hagen, or the egg burster. Just before hatching, it appears quite dark or black, perhaps due to an increase in chitinization. Hatching can be readily observed without a long wait by taking some eggs from a cluster for observation in which most have already hatched.

A brief account of a typical instance of hatching follows: The embryo began a series of movements calculated to pull the tip of the abdomen towards the posterior pole of the egg. This region became crowded and the embryo pushed upwards and outwards slowly. The upward movement was rather quick and with some effort, while the downward one appeared to be a slipping back to its previous position. Along with these movements, there was some outward pressure brought to bear

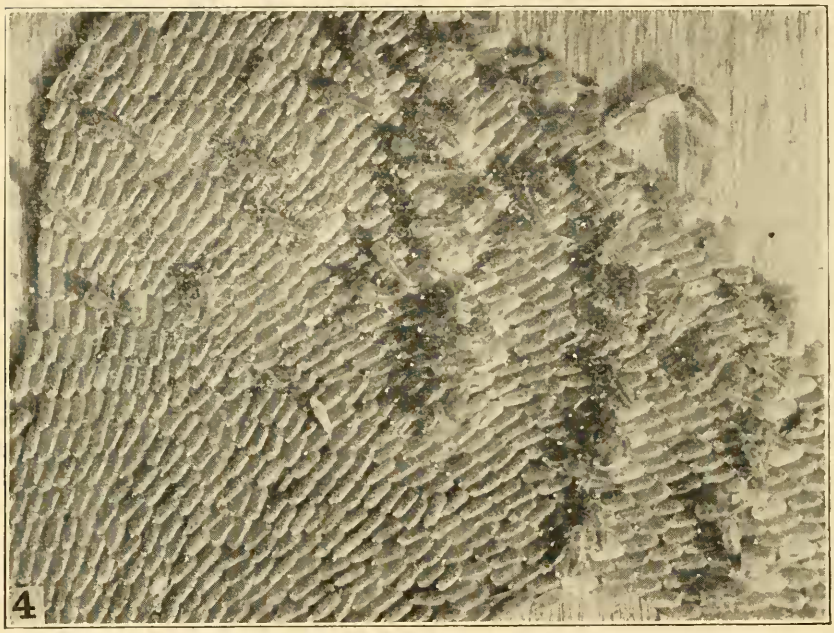

Fig. 4. An egg mass of *Chauliodes pectinicornis* hatching. (Photo by H. S. Barber, 1912).

on the head region which culminated in the penetration of the chorion by the upper lobe of the burster. It was later observed that it is frequently difficult to ascertain if it has cut through the chorion or whether it is merely closely appressed. In this case, two whitish triangular areas appeared on each side of the burster, their bases next to it. The writer interpreted these as air bubbles beneath the chorion, the edges of which had been raised up in the cutting process. As the embryo continued the upward pressure, the burster was pushed through

for its entire length, cutting the chorion before it. The rent was then torn at both ends, chiefly the upper, by the outward pressure of the head of the embryo. The dorsum of the head is pushed through the opening, perhaps aided some by blood pressure, and as a consequence, the slit in the chorion tore anteriorly to the micropyle. The abdomen was the pushing agency. It moved upward by a series of contractions and expansions, pushing the thorax before it. The mouthparts and legs appeared to be held by the embryonic molt so that they lagged behind in emergence. The chorion slipped back over the eyes as the thorax was pushed up and the burster with the molt remained at the lower part of the incision with the cast skin. The embryonic molt was attached to the inside of the chorion in the mid-ventral line just below the rent. Sufficient strain was exerted on this molt by the emergence of the embryo to cause it to tear over the thorax in the mid-dorsal line. The upward pushing continued and the thorax became arched over the egg. As the thorax and abdomen appeared, the setæ thus freed sprang into their normal position. When the abdomen was well out of the egg, the larva began to straighten up. This withdrew the mouthparts and the legs from the molt. They were drawn out slowly and finally the claws were freed after some difficulty.

As soon as the mouthparts and legs were freed, the larva raised itself erect and even bent backwards. By these movements it separated the appendages from each other, for they appeared to adhere slightly. During this performance and until the chitin was hard, the larva supported itself wholly by the end of the abdomen. Finally, after some ten minutes, the larva brought itself forward and rested on its legs. It then rested for a few minutes longer, after which it sought the stalk of the egg by which it descended to the substratum.

Later observations show that it is not always the upper lobe which first pierces the chorion. Sometimes it appears that the whole burster is slowly pushed through the chorion at about the same time. Larvæ rest for a varying length of time on the egg shell. Generally is it about fifteen or twenty minutes, but this period may be much prolonged. One often sees a batch of eggs with a larva resting on each. The empty shells are pure white, and all have a prominent

rent at the upper end to one side of the micropyle. The embryonic molt generally protrudes slightly from the lower end of the rent.

The burster is a saw-toothed carina, .118 mm. long, and .029 mm. wide at the lobe. In cross section the burster is V-shaped, due to the broadening at the base. There are 20 to 30 minute teeth along the cutting edge of the burster. The lobe generally has a sharp tooth at its tip, but not always. The bursters of other species of Chrysopa as far as seen are practically identical with that of this species, and hatching shows no essential variations.

The writer has observed hatching a great many times in each of these families, but especially among the Chrysopidæ and Hemerobiidæ. At no time has the egg bursters been observed to fail in their critical period of usefulness. Embryos sometimes die before hatching, but no case has yet been seen where it was thought that death had occurred because the egg burster had failed to cut the chorion. They are highly efficient structures.

BIBLIOGRAPHY.

1852. **Hagen, H. A.** Die Entwickelung und der innere Bau von Osmylus. Linnaea Entomologica, 7:368-418, 4 pl.

1859. **Hagen, H. A.** Ausschupfen von Chrysopa larven. Stettiner Ent., Zeit. 20:333.

1880. **Hagen, H. A.** Note on Hatching. Psyche, 8:416.